UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/633,598	08/07/2000	John M. Redwing	410	2700

7590 06/05/2002

Oliver A Zitzmann
ATMI Inc
7 Commerce Drive
Danbury, CT 06810

EXAMINER	
LOUIE, WAI SING	
ART UNIT	PAPER NUMBER
2814	

DATE MAILED: 06/05/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 07-01)

Office Action Summary	Application No. 09/633,598	Applicant(s) REDWING ET AL.
	Examiner Wai-Sing Louie	Art Unit 2814

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *20 March 2002*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-9 and 11-34* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-9 and 11-34* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 4.
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Response to Amendment

The amendment filed 3/20/02 is objected to under 35 U.S.C. 132 because it introduces new matter into the disclosure. 35 U.S.C. 132 states that no amendment shall introduce new matter into the disclosure of the invention. The added material which is not supported by the original disclosure is as follows:

- In claim 13, line 2, "Indium segregation or separation" is new matter.
- In claim 15, line 2, "defect degeneration" is new matter.
- In claim 16, line 2, "TCE engineered effects" is new matter.
- In claim 18, line 1, "a strained AlGaN/InGaN layer" is new matter.
- In claim 19, line 1, "a strained GaN/InGaN layer" is new matter.
- In claim 20, line 1, "a strained InGaN/InGaN layer" is new matter.
- In claim 24-26, "sheet charge" is new matter.
- In claim 27 and 28, "lifetime" and "RF operation" are new matter.
- In claim 32, "% lattice mismatch" is new matter.

Applicant is required to cancel the new matter in the reply to this Office Action.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 13, 16, 24-28, and 32 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

- In claim 13, line 2, "Indium segregation or separation" is new matter.
- In claim 15, line 2, "defect degeneration" is new matter.
- In claim 16, line 2, "TCE engineered effects" is new matter.
- In claim 18, line 1, "a strained AlGaN/InGaN layer" is new matter.
- In claim 19, line 1, "a strained GaN/InGaN layer" is new matter.
- In claim 20, line 1, "a strained InGaN/InGaN layer" is new matter.
- In claim 24-26, "sheet charge" is new matter.
- In claim 27 and 28, "lifetime" and "RF operation" are new matter.
- In claim 32, "% lattice mismatch" is new matter.

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 15 and 16 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

- In claim 15, line 2, it is unclear what "defect degeneration" means.
- In claim 16, line 2, it is unclear what "TCE engineered effects" means.

- In claim 9, line 3, it is unclear what "piezo-electrically induced charge" means.

From previous office action:

- In claim 9, line 2, it is unclear what is meant by "increasing the sheet density"?

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-2, 14, 21, 29, and 33-34 (in so far as they are understood) are rejected under 35 U.S.C. 103(a) as being unpatentable over Maeda et al. (JP 11-274474) in view of Streit et al. (US 5,668,387).

With regard to claims 1 and 33, Maeda et al. disclose a gallium nitride-based HEMT device (page 1-5), comprising a channel layer formed of an InGaN alloy (page 3, line 10), but do not disclose the channel layer is at least partially relaxed. However, Streit et al. disclose a pseudomorphic high electron mobility transistor (HEMT) having a partially relaxed channel layer 22. Streit et al. teach a pseudomorphic HEMT could have a thicker channel layer to excess the allowed critical thickness (CT) and lead to higher electron concentration in the channel layer (Streit col. 1, line 41 to col. 2, line 20). Therefore, it would have been obvious to one with ordinary skill in the art to provide a relaxed channel layer in order to increase the electron flow through the channel layer to have a high efficiency HEMT device.

With regard to claims 2, please see the description of record.

With regard to claim 14, Maeda et al. modified by Streit et al., in claim 1 above, would disclose a pseudomorphic (HEMT) having a partially relaxed channel layer. Streit et al. teach when the thickness of the channel layer reaches a CT at a particular indium concentration, the strain in the channel layer becomes large enough that the channel layer relaxes and the dislocation is formed (Streit col. 1, lines 55-59). Therefore, it is obvious the channel is relaxed by means of dislocation generation.

With regard to claim 21, Maeda et al. disclose an InGaN channel 14 and an AlGaN barrier layer 15 (fig. 12). They have different lattice constants and therefore, it is obvious to have strain at the interface of two layers.

With regard to claim 29, Maeda et al. disclose an InGaN channel, which is the same material as present claimed invention. Therefore, it is obvious to have the same mobility.

With regard to claim 34, Maeda et al. modified by Streit et al., in claim 1 above, would disclose a pseudomorphic (HEMT) having a partially relaxed channel layer. Streit et al. disclose the relaxed channel layer contains less than 30% of indium in the alloy (Streit col. 3, line 59). The original indium content is 28% (col. 3, line 61). Since the criticality has not been establish, the percentage is considered as equivalent.

Claims 3 and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maeda et al. (JP 11-274474) in view of Nagahama et al. (US 6,172,382).

With regard to claims 3 and 6, please see the description of record.

Claims 4 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maeda et al. (JP 11-274474) in view of Yoshida (JP 11-261053).

With regard to claims 4 and 5, please see the description of record.

Claims 7 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maeda et al. (JP 11-274474) in view of Kawai et al. (US 5,929,467).

With regard to claims 7 and 8, please see the description of record.

Claims 9, 15, and 22-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maeda et al. (JP 11-274474) modified by Streit et al. (US 5,668,387) as applied to claim 1 above, and further in view of Hoke et al. (US 5,448,084).

With regard to claim 9, Maeda et al. do not disclose the AlGaN layer comprising a dopant to increase the sheet density beyond the piezo-electrically induced charge. However, Hoke et al. disclose a pseudomorphic HEMT having a channel layer 42 with the thickness above the critical thickness (Hoke col. 7, line 50) and a n-doped charge donor layer 44 comprised of higher bandgap material, which is lattice match with the channel layer (Hoke col. 7, lines 35-37). Hoke et al. teach the pseudomorphic strained AlGaAs/InGaAs structure would lead to very high sheet density. The strain provided in the InGaAs channel would be opposite to and thus compensate for the strain provided in the AlGaAs layer (Hoke col. 8, line 5-12). Although, Hoke et al. teach an InGaAs/AlGaAs structure, but one with ordinary skill in the art would apply the teaching to an InGaN/AlGaN structure. Therefore, it would have been obvious to one with ordinary skill in the art to provide an AlGaN with dopant to increase the sheet density beyond the piezo-

electrically induced charge. Doing so would increase the stability of the InGaN/AlGaN pseudomorphic structure.

With regard to claim 15, Maeda et al. do not disclose the relaxed channel is relaxed by means of defect degeneration. However, Hoke et al. disclose a pseudomorphic HEMT having a channel layer 42 with the thickness above the critical thickness (Hoke col. 7, line 50). Therefore, when the channel layer could grow thicker than the CT, the channel layer is relaxed (see claim 1 above). Hoke et al. teach with increasing indium concentration, the CT at which the InGaAs layer forms crystal defect decreases (or degenerated) (Hoke col. 2, lines 42-45). Therefore, it is obvious the defect degenerated would lead to relaxing of the channel layer.

With regard to claims 22-23, Maeda et al. do not disclose the electron distribution substantially located in the relaxed channel and with maximum charge located within 25Å of upper barrier/channel interface. However, Hoke et al. disclose the sheet density of carriers maximize in the channel layer 42 (Hoke col. 7, lines 59-60). The charge donor layer 44 interfaces with the channel layer 42 (fig. 4). One with ordinary skill in the art would know the sheet carriers are at the interface with the charge donor layer. Therefore, it is obvious the maximum charge would be located within 25Å of the layers interface.

Claims 11-13 and 30-32 (in so far as they are understood) are rejected under 35 U.S.C. 103(a) as being unpatentable over Maeda et al. (JP 11-274474) modified by Streit et al. (US 5,668,387) as applied to claim 1 above, and further in view of Jewell et al. (US 5,960,018).

With regard to claim 11, Maeda et al. modified by Streit et al. in claim 1 would have a partially relaxed channel layer, but do not disclose the InGaN channel layer is graded. However,

Jewell et al. disclose a pseudomorphic LED having an active layer, which is smoothly graded multiple quantum well, MQW (Jewell col. 23, lines 59-63 and fig. 5F). Jewell et al. teach the MQW could be grown to more than its CT without creating high densities of misfit dislocation (Jewell col. 23, lines 63-65). Therefore, it would have been obvious to one with ordinary skill in the art to provide a graded InGaN channel layer in order to grow more than the CT to allow more current flow.

With regard to claim 12, Maeda et al. modified by Nagahama et al., in claim 3 above, would disclose an AlInGaN channel layer, but do not disclose a graded structure to relax the strain built-up due to the larger Indium molecule. However, Jewell et al. teach a graded partially relaxed InGaN channel in claim 11 above. Therefore, it is obvious the technique could apply to an AlInGaN alloy layer.

With regard to claim 13, Maeda et al. modified by Jewell et al., in claim 11 above, would disclose a relaxed channel. Jewell et al. teach the InGaAs and GaAsSb alloys, which have similar lattice constants. By adding In or Sb could increase the peak transition energy (col. 31, lines 50-62). Therefore, the channel could be relaxed by changing the mole fraction of indium (indium segregation). Therefore, it is obvious to relax the channel layer by indium segregation.

With regard to claims 30-31, Maeda et al. do not disclose the bandgap energy of AlInGaN. However, 0.1 eV is a very low value and Jewell et al. disclose a chart (fig. 11) to show the bandgap energy vs. lattice constant of different semiconductor compounds. GaAsN and InGaAs have a bandgap of 0.8 eV. With the addition of aluminum in the compound, the value would be much higher. Therefore, it is obvious to have a bandgap energy greater than 0.1 eV.

With regard to claim 32, Maeda et al. do not disclose the barrier/buffer interface with less than 5% lattice mismatch. However, the buffer is GaN and the barrier layer is AlGaN. One with ordinary skill in the art would know the lattice constant of GaN and AlGaN is very close (3.198Å and 3.112Å). Therefore, it is obvious the lattice mismatch is less than 5%.

Claim 17 is rejected under 35 U.S.C. 103(a) as being unpatentable over Maeda et al. (JP 11-274474) modified by Streit et al. (US 5,668,387) as applied to claim 1 above, and further in view of O'Loughlin et al. (US 5,028,968).

With regard to claim 17, Maeda et al. modified by Streit et al. in claim 1 would have a partially relaxed channel layer, but do not disclose the relaxed channel comprises n-type dopant. However, O'Loughlin et al. disclose a HEMT having an unintentional doped channel (O'Loughlin col. 2, line 37). O'Loughlin et al. teach this would reduce impurity scattering and maintain the high electron mobility (O'Loughlin col. 2, lines 41-43). Therefore, it would have been obvious to one with ordinary skill in the art to provide an unintentional doped channel layer in order to reduce impurity scattering in the HEMT device.

Response to Arguments

Applicant's arguments filed 3/20/02 have been fully considered but they are not persuasive.

- Applicant indicated "increasing the sheet density" is recorded in page 3, line 22 to page 4, line 2. However, there is no mention of sheet density in this paragraph. The 35 U.S.C. 112, second paragraph remains as stated.
- Applicant argues that Maeda et al. do not teach the relaxed channel layer as shown in the amended claim 1. However, Maeda et al. disclose the relaxed channel layer and the changes in critical thickness in paragraph [0007]. However, the orginal English version is not available. Therefore, Streit et al. is added to the rejection. Please see the rejection above.
- Applicant argues that the GaN lower barrier and the GaN upper barrier not disclosed by Maeda et al. However, they are not listed in the claims. The argument is moot.
- Applicant argues that Nagahama et al. disclose a InGaN/InGaN MQW, which may have a doped InGaN barrier layer, would reduce the threshold value. However, the threshold value is not in the claim and Nagahama et al. meets the claimed limitation.
- Applicant argues that Nagahama et al. disclose an n-AlGaN carrier-trapping layer, which causes depletion of the n-AlGaN layer. However, depletion is not in the claim. The argument is moot.
- Applicant argues that Yoshida contains no aluminum and paragraph [0014] states that aluminum causes mismatch among the layers. Yes, Yoshida contains **NO** aluminum and that meets the limitation of claim 4 and claim 5.

- Applicant argues that Kawai et al. disclose an intrinsic AlGaN layer adjacent to the active layer. An intrinsic layer is an undoped layer and meets the claim limitation.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Wai-Sing Louie whose telephone number is (703) 305-0474. The examiner can normally be reached on 7:30 AM to 4:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on (703) 306-2794. The fax phone numbers for the

organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

wsl
June 1, 2002

OLIK CHAUDHURI
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800